REMARKS

The applicant affirms the election that was made on 20 October 2005. Claims 13 to 20 are withdrawn from further consideration by the Examiner.

On page 3 of the Office Action, the Examiner rejected claims 1-12 under 35 USC §103(a) as being unpatentable over Roy et al. (U.S. Patent No. 6,331,283) in view of Leffer (U.S. Patent No. 2,698,281).

The subject invention, as claimed in the amended claims, incorporates an important distinction in the applicant's process compared to the prior art. *The location of oxidant addition into the reactor and the location of the perm-selective membranes in the reactor are physically separated.* If the oxidant is air, then nitrogen in the air in large part bypasses the perm-selective membranes.

This separation is important for two reasons. First, to efficiently permeate hydrogen through the perm-selective membranes, the concentration of hydrogen must be as high as possible at the surface of the membranes to maximize the hydrogen flux. Separating the reactor into two zones therefore not only separates the endothermic and exothermic reactions and circulates heat, but the separation prevents the nitrogen, which enters with the oxygen in the air, from diluting the hydrogen when it encounters the surfaces of the perm-selective membranes in the reforming zone. Although pure oxygen can be used instead of air, oxygen is expensive and causes overheating in the vicinity where it enters. Thus it is a great advantage to be able to use air in the reactor. This first important advantage is discussed in the specification at page 11, lines 9 to 13.

The physical separation of the endothermic and exothermic reactions into two zones has a second important advantage. Although heat is dissipated quickly in fluidized beds, hot temperatures are present locally when oxidation gas is injected as jets (see, for example, Fig. 3 of Roy et al.). Palladium-based membranes have a practical upper operating temperature of approximately 650°C, so unless the membranes are kept well away from the hot oxidation zone, membrane damage can result. By separating of the reactions into two zones, and locating the membranes in the cooler zone, the membranes are protected from heat damage. This second important advantage is discussed in the specification at page 11, lines 13 to 16.

Turning to Roy et al. and Leffer, it is noted that Roy et al. do not disclose a fluidized bed reactor wherein the endothermic dehydrogenation reaction zone is physically separated by a

barrier from the exothermic oxidation or partial oxidation reaction zone. In Roy et al., methane and steam are introduced in the bottom of the fluidized bed reactor at 22. The methane and steam gases travel upwardly through the interior of the fluidized catalyst bed. Oxygen is introduced into the lower region of the fluidized bed reactor through oxygen input 16. No separation of reaction zones takes place. Hydrogen produced from the reactions is separated through separator membranes 18 which are located in the interior of the reactor 12.

The fluidized bed reactor disclosed by Roy et al. thus has two major shortcoming. First, if air rather than pure oxygen is used, the nitrogen in the air (approximately 79%) dilutes the hydrogen in the membrane zone and significantly inhibits efficient hydrogen transmission through the perm-selective membranes.

Secondly, in Roy et al., the oxidant is introduced into the reactor in a location which is very close to the perm-selective membranes. Hence local "hot spots" develop which can damage the perm-selective membranes.

Leffer, on the other hand, discloses a triple chamber reactor design which has downwardly traveling outer and inner reaction zones and an annular oxidizing zone located between the inner and outer chambers. Leffer does not disclose perm-selective membranes. Thus, Leffer was not concerned with the problems of maintaining high hydrogen concentrations at the membranes, and preventing membrane damage. Leffer was concerned with other non-related problems and discloses at least three reactant streams. These streams comprise commingling a fluid reactant stream with subdivided solid particles at conversion conditions and passing the mixture upwardly in a confined path to the upper portion of a confined inner reaction zone, reversing the direction of flow of the resulting fluid stream and subdivided particles and passing them concurrently downwardly in a relatively compact descending bed to a lower portion of the inner reaction zone. The resulting fluid product stream is separated from the lower portion of the descending bed of particles and this product stream is discharged from the reaction zone (see column 1, lines 60-75).

The principal object of Leffer is not to generate hydrogen gas from a hydrocarbon gas and steam mixture. Leffer's process and apparatus utilize subdivided solid particles which are of a material other than catalyst and may affect the conversion other than fluid hydrocarbonaceous reactant streams (see column 1, lines 24-26). Leffer's process and apparatus are particularly adapted to affect the catalytic cracking of hydrocarbon vapors or other related catalytic processes for the conversion of a hydrocarbonaceous reactant fluid,

and the regeneration of the catalyst particles so that they may be utilized in a continuous cyclic operation. There is no teaching or direction in Roy et al. that their teachings can be combined with the teachings of Leffer.

For the foregoing reasons, it is submitted that a person skilled in the art would not be inclined to combine the teachings of Leffer with the teachings of Roy et al. It is therefore submitted that the amended claims, including amended claim 1, dependent claims 2 to 12 and new claim 21, patentably distinguish Roy et al. and Leffer.

On page 6 of the Office Action, the Examiner rejected claim 3 under 35 USC §103(a) as being unpatentable over Roy et al. in view of Leffer and Nataraj et al. (U.S. Patent No. 6,110,979). It is noted that Naturaj et al disclose a fixed bed (not a fluidized bed) reactor. Furthermore, the membranes are oxygen permeable rather than hydrogen permeable (see column 9, lines 27-31). Technology relating to fixed bed reactors and oxygen permeable membranes is entirely different from the technology associated with the applicant's invention and accordingly it is submitted that the citation of Nataraj et al. pertains to non-analogous art.

On page 7, the Examiner rejected claim 7 under 35 USC §103(a) as being unpatentable over Roy et al., in view of Leffer and Nataraj et al., and Ruotto et al. (U.S. Patent No. 6,045,688). Ruotto et al. do not disclose a barrier between reaction zones, or perm-selective membranes. It is submitted that combining four separate patents, none of which point to the others, does not amount to a supportable basis for raising an obviousness rejection. Withdrawal of the rejection of claim 7 on the basis of a combination of Roy et al., Leffer, Nataraj et al. and Ruotto et al. is solicited.

For the reasons submitted above, and taking into account the amendments to the claims, it is submitted that this application is now in condition for allowance and this action at an early date is respectfully solicited.

Respectfully submitted,

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